ASTROPHYSICS

Identifying Polycyclic Aromatic Hydrocarbons in Space

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Polycyclic aromatic hydrocarbon (PAH) molecules are the most abundant family of molecules in the interstellar medium after molecular hydrogen and carbon monoxide, and they contain about 10% of all the interstellar carbon. Extremely tough PAH molecules are a component of meteorites, and thus were likely delivered to the early Earth where they may have played an important role in the formation of life. Until recently, the only way to study PAHs in the interstellar medium was by examining their emission spectrum. PAHs fluoresce when present near sources of bright ultraviolet radiation such as exits in planetary nebulae and HII (ionized hydrogen) regions. PAH absorption spectra have been measured in laboratory studies, but these spectra cannot be directly used to determine the mix of PAHs that occurs in the interstellar medium without using complex models. Enough unknowns exist in the models that definitive statements about the exact nature of the interstellar PAHs have so far been impossible.

Recently, a spectral database has become available from the Infrared Space Observatory that contains objects in which the C-H PAH stretch feature (near 3.26 microns (μm)) has been found in absorption. If the database of isolated neutral PAHs generated by the Ames Astrochemistry Laboratory is used, the interstellar feature can be matched fairly well with a mixture of PAH molecules. However, the mixture is not unique and does not indicate which particular PAHs are present in space. This fact is demonstrated in the figure, which shows two fits to the absorption observed toward the protostellar source S140. The laboratory database contains only a few PAHs as large as those expected to survive the rigors of the interstellar medium, so it is perhaps not surprising that a precise match is still not possible. Techniques for obtaining lab spectra of larger PAHs exist, but making large PAHs for lab studies is very difficult. As soon as such lab data exist, being able to directly compare lab and interstellar spectra without using uncertain models could provide the first identification of individual PAHs in space.

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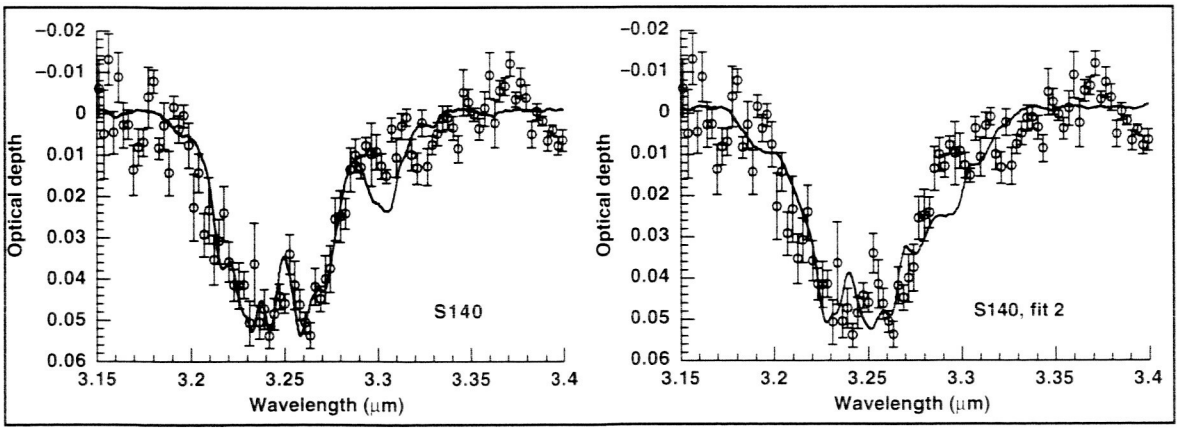

Fig. 1. The spectrum of S140 has been divided by an estimate of the continuum to allow direct comparison with laboratory data of PAHs. The two panels show different mixtures of laboratory PAHs (solid lines) plotted on top of the S140 data points.